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B.TECH AGRICULTURAL ENGINEERING
SEMESTER IV

COURSE CODE	CATEGORY	COURSE NAME	L	P	CREDITS	TEACHING & EVALUATION SCHEME				
						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTAE401	**DCS**	**Engineering Properties of Agricultural Produce**	1	1	2	50	30	0	15	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objective: 1.To study the importance of principles of processing and food Engineering in agriculture

2. To study engineering properties of agriculture produce.

Course Outcome: 1. Student will be able to understand the principles of processing in food engineering.

2. Student will be able to understand engineering properties of agricultural produce for handling of these by machines.

Unit: 1
Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables,

Unit: 2
Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion,

Unit: 3
Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials,

Unit: 4
Aero dynamics of agricultural products drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non- Newtonian fluid, Pseudo-plastic,

Unit: 5
Dilatants, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures

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Practical:

Determination of the shape and size of grains, fruits and vegetables, Determination of bulk density and angle of repose of grains, Determination of the particle density/true density and porosity of solid grains, Finding the co-efficient of external and internal friction of different crops, Finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel, Finding the thermal conductivity of different grains, Determination of specific heat of some food grains, Determination of hardness of food material and determination of viscosity of liquid foods.

Suggested Readings

1. Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers , New York.
2. Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.
3. Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.
4. Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.

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						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTAE 402	DCS	Watershed Hydrology	1	1	2	50	30	0	15	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objectives:

1. The students will be able to familiarize with fundamentals of watershed hydrology.
2. To apply the principles of hydrology to practical agricultural problem.
3. To develop the ability to quantify the magnitude of hydrologic entities in small watersheds.
4. To learn the fundamentals of hydrologic analysis in watershed management such as rainfall and hydrographs.
5. To understand the concepts of stream gauging and draught.

Course Outcomes:

1. Students will be able to apply and demonstrate the concepts of watershed hydrology.
2. Students will be able to demonstrate precipitation and rainfall measurement.
3. Students will be able to demonstrate geomorphology of watersheds and hydrograph.
4. Students will be able to explain and apply hydrologic processes and evaporation
5. Students will be able to determine the concepts of stream gauging and draught.

Syllabus:

UNIT I

Basic Concepts of Hydrology: Introduction, Scope of Hydrology, Definition of Hydrology, Hydrologic cycle, Applications of Hydrology, Global water Resources, Water resources of India, and Water requirements of India.

UNIT II

Precipitation and Rainfall Measurement: Precipitation and its forms, Rainfall measurement: non-recording gauge, recording or automatic gauge, Errors in Rainfall Measurements, Rain gauge, Network estimation of mean rainfall: Arithmetic Average Method,Thiessen Polygon Method,Isohyetal Method, frequency analysis of point rainfall, Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship.

UNIT III

Hydrologic Processes and Evaporation: Hydrologic processes-Interception, infiltration-factors influencing, measurement and indices. Evaporation - Estimation and measurement. Runoff Factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method.

UNIT IV

Geomorphology of Watersheds and Hydrograph: Geomorphology of watersheds - Linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency.

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Hydrograph - Components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations.

UNIT V

Stream Gauging and Draught - Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood, Flood routing channel and reservoir routing, Drought, classification of drought, causes and impacts, drought management strategy.

Text Books:

1. Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
2. Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.

Reference Books:

1. Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.
2. Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
3. Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition,New Age International (P) Limited Publishers, New Delhi.
4. Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co.,New Delhi.
5. Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi.
6. Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

List of Practical's:

1. Visit to meteorological observatory and study of meteorological instruments
2. Study of different types of rain gauges.
3. Analysis of rain gauge charts.
4. Estimation of average rainfall depth.
5. Probability analysis of rainfall data by Weibull's method.
6. Estimation of peak runoff rate by rational method.
7. Estimation of peak runoff rate by Cook's method.
8. Computation of runoff volume by Curve Number method.
9. Study of stream gauging instruments (Stage level recorder and current meter).
10. Development of DRH from stage hydrograph.
11. Development of unit hydrograph.
12. Development of Dimensionless Unit Hydrograph Problems relating to stresses in beams.

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SEMESTER IV

COURSE CODE	CATEGORY	COURSE NAME	L	P	CREDITS	TEACHING & EVALUATION SCHEME				
						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment *	END SEM University Exam	Teachers Assessment *
BTAE 403	**DCS**	**Sprinkler and Micro Irrigation Systems**	1	1	2	50	30	0	15	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objectives:

1. To provide students basics knowledge about sprinkler irrigation their adaptability.
2. To provide students basics about design and selection of pumps for sprinkler irrigation system.
3. To learn general considerations, wetting patters, irrigation requirement.
4. To understand maintenance of micro irrigation system.
5. To understand various precautions for successful fertigation system.

Course Outcomes:

1. The students will be able to familiarize with different Sprinkler irrigation system.
2. The students will be able to design and select pump and power unit for sprinkler irrigation system.
3. Students will be able identify micro Irrigation Systems: types-drip, spray, & bubbler systems. They understand merits and demerits.
4. Student will be able to understand and design hydraulics of drip irrigation system.
5. Student will be able to understand fertigation.

Syllabus:

UNIT I

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, submain and main pipe line.

UNIT II

Design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency.

UNIT III

Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection.

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UNIT IV

Hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

UNIT V

Fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

Text Books:

1. Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .
2. Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.
3. Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.

Reference Books:

1. Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.
2. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.
3. Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.

List of Practical's:

1. Study of different components of sprinkler irrigation system.
2. Design and installation of sprinkler irrigation system.
3. Determination of precipitation pattern, discharge and uniformity coefficient.
4. Cost economics of sprinkler irrigation system.
5. Study of different components of drip irrigation; design and installation of drip irrigation system.
6. Determination of pressure discharge relationship and emission uniformity for given emitter.
7. Study of different types of filters and determination of filtration efficiency; determination of rate of injection and calibration for chemigation/fertigation.
8. Design of irrigation and fertigation schedule for crops.
9. Field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.

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COURSE CODE	CATEGORY	COURSE NAME	L	P	CREDITS	TEACHING & EVALUATION SCHEME				
						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTAE 404	**DCS**	Tractor and Automotive Engines	2	1	3	50	30	0	15	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objectives:

1. To develop the basic knowledge of the students in Tractor and connected all intricate parts.
2. To develop the basics of the students in the field of automotive engines and related parts.
3. To develop the skills of the Students in the areas of functioning of automotive drive line and concept on performance measurement.

Course Outcomes:

1. Students would be able to understand the working principle of Tractor engine and the forces acting on tractor chassis frame.
2. Students would be able to understand the Steering system and Suspension system of the tractor.
3. Students would be able to understand about the performance of Tractor based on road condition for safe ride and performance.
4. Students would be able to understand about the Tractor driving stability and a specified norms for maintenance.

Syllabus:

UNIT I

Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) 178 179 Report of the ICAR Fifth Deans' Committee Report of the ICAR Fifth Deans' Committee engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions.

UNIT II

Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system.

UNIT III

Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines.

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UNIT IV

Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing – need of governors, governor types and governor characteristics.

UNIT V

Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing

Text Books:

1. Singh Kirpal. Automobile Engineering – Vol II.
2. Heitner Joseph. Automotive Mechanics : Principles and Practices

Reference Books:

1. Liljedahl J B and Others. Tractors and Their Power Units. y Rodichev V and G Rodicheva. Tractors and Automobiles.
2. Mathur ML and RP Sharma. A course in Internal Combustion Engines.

List of Practical's:

1. Study of Engine parts and functions, working principles
2. Study of Valve system – construction and adjustments
3. Study of Air cleaning system
4. Study of Fuel supply system of SI engine
5. Study of Diesel injection system & timing
6. Study of Cooling system, and fan performance
7. Study of Lubricating system & adjustments
8. Study of Starting and electrical Ignition system

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COURSE CODE	CATEGORY	COURSE NAME	L	P	CREDITS	TEACHING & EVALUATION SCHEME				
						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTAE 405	DCS	IRRIGATION ENGINEERING	2	1	3	50	30	0	15	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objectives:

1. The students will be able to measurement of soil moisture by different soil moisture measuring instruments.
2. To apply the principles of design of underground pipeline system.
3. To identify environmental impact of irrigation projects
4. To learn the fundamental concepts of irrigation efficiency.
5. To develop simple model for estimation of evapotranspiration.

Course Outcomes:

1. Students will be able to understand the management of irrigation system.
2. Students will be able to have knowledge and skill on crop water requirements.
3. Students will be able to understand various types of irrigation methods and their Analysis.
4. Students will be able to understand various modes of conveying irrigation water.
5. Students will be able to understand land levelling design methods and its criteria for land levelling.

Syllabus:

UNIT I

Introduction- Definition, Necessity, Scope, Benefits and ill effects of irrigation, source of irrigation water, Major and medium irrigation schemes of India, Social and environmental considerations, Irrigation development in India. Environmental impact of irrigation projects, present status of development and utilization of different water resources of the country.

Soil water plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response.

UNIT II

Water Requirement of Crops: Field capacity, wilting point, available water, consumptive use, Irrigation requirements, Net irrigation requirement, Field irrigation requirement, Gross Irrigation requirement, Soil moisture extraction pattern, Frequency of irrigation, Principal Indian crops, Gross command area, Culturable command area, Intensity of irrigation, Duty and delta relation, concept of evapotranspiration (ET), measurement and estimation of ET.

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UNIT III

Methods of Irrigation: Classification- choice of method of irrigation- surface and subsurface irrigation methods, Sprinkler and Drip Irrigation.

Measurement of irrigation water: weir, flumes and orifices and other methods.

UNIT IV

Modes of conveying irrigation water: Open channel water conveyance system, design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution, types of irrigation canals contour canal, ridge canal, side sloping canals, Canal sections-filling, cutting, partial cutting and partial filling, Balanced depth, Canal FSL, Capacity factor and Time factor, L-section, Losses of canal water, Silting and scouring of canals, Method of design of unlined section of irrigation canal, Silt theories, Lined canals, Design of lined canal, Link canals, underground pipe conveyance system: components and design.

UNIT V

Land grading: criteria for land levelling, land levelling design methods, estimation of earth work.

Surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations.

Text Books:

1. Dilip Kumar Majumdar, "Irrigation Water Management", Prentice-Hall of India, New Delhi, 2008.
2. Punmia B.C., et. al; Irrigation and water power Engineering, Laxmi Publications, 16th Edition, New Delhi, 2009
3. Garg S. K., "Irrigation Engineering and Hydraulic structures", Khanna Publishers, 23rd Revised Edition, New Delhi, 2009

Reference Books:

1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
2. Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.
3. Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.
4. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
5. Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice,John Wiley & Sons, Inc. USA.

List of Practical's:

1. Problems on irrigation requirement of crops.
2. Demonstration of different methods of irrigation.
3. Calculations on irrigation efficiencies.
4. Determination of pH of irrigation water.
5. Scheduling of irrigation based on soil moisture depletion approach.
6. Measuring infiltration rate of soil.

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7. Determination of field capacity of soil.
8. Problems relating to soil moisture measurement by thermogravimetric and tensiometric methods.
9. Determination of Ca+ Mg in irrigation water.
10. Measuring soil moisture with gypsum blocks.

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						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTAE406	DCS	**Fundamentals of Renewable Energy Sources**	2	1	3	50	30	0	15	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objectives:

1. To understand basic characteristics of renewable sources of energy and technologies for their utilisation.
2. To give review on utilisation trends of renewable sources of energy.
3. To develop the devices and instruments which provide the knowledge for proper utilization of energy resources.
4. To create the people who will teach the science of Renewable Energy, this will be also helpful for the promotion of Research in this field.

Course Outcomes:

1. Students will be able to apply and demonstrate basic properties of different renewable sources of energy and technologies.
2. Students will be able Describe main elements of technical systems designed for utilization of renewable sources of energy.
3. Students will be able to interpret advantages and disadvantages of different renewable sources of energy.
4. Students will be able explain the correlation between different operational parameters.

SYLLABUS:

UNIT I

Basic Concepts of Renewable Energy Sources: Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources.

UNIT II

Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced Convection drying system.

UNIT III

Solar Photo voltaics : p-n junctions. Solar cells, PV systems, stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics.

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UNIT IV

Wind Energy: Energy available from wind, General formula, Lift and drag, Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, working principle of wind power plant.

UNIT V

Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs.
Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Text Books:

1. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
2. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
3. Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.

Reference Books:

1. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources,
2. Himanshu Publications.
3. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

List of Practical's:

1. Study of different types of solar cookers.
2. To study solar water heating system.
3. To study natural convection solar dryer.
4. To study forced convection solar dryer.
5. To study solar desalination unit.
6. To study solar greenhouse for agriculture production, biogas plants, biomass gasifiers, biomass improved cook-stoves, solar photovoltaic system.

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						THEORY			PRACTICAL	
						END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
BTAE 407	DCS	Auto CAD Applications	0	2	2	-	-	-	60	40

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; C - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class.

Course Objectives:

1. The students will be able to familiarize with Auto CAD.
2. The students will be able to understand the applications of both the 2D and 3D formats.
3. Students will be able to use Auto CAD tools to design the industry architectures and project management.

Course Outcomes:

1 Demonstrate basic concepts of the AutoCAD software.
2 Apply basic concepts to develop construction (drawing) techniques.
3 Ability to manipulate drawings through editing and plotting techniques.
4 Understand geometric construction.
5 Produce template drawings.

Practical

Application of computers for design. CAD- Overview of CAD window – Explanation of various options on drawing screen. Study of draw and dimension tool bar. Practice on draw and dimension tool bar. Study of OSNAP, line thickness and format tool bar. Practice on OSNAP, line thickness and format tool bar. Practice on mirror, offset and array commands. Practice on trim, extend, chamfer and fillet commands. Practice on copy, move, scale and rotate commands. Drawing of 2 D- drawing using draw tool bar. Practice on creating boundary, region, hatch and gradient commands. Practice on Editing polyline- PEDIT and Explode commands. Setting of view ports for sketched drawings. Printing of selected view ports in various paper sizes. 2Ddrawing of machine parts with all dimensions and allowances- Foot step bearing and knuckle joint. Sectioning of foot step bearing and stuffing box. Drawing of hexagonal, nut and bolt and other machine parts. Practice on 3-D commands- Extrusion and loft. Practice on 3-D commands on sweep and press pull. Practice on 3-D Commands- revolving and joining. Demonstration on CNC machine and simple problems.

Text Books:

1. Zeid Ibrahim. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt.Ltd., New Delhi.
2. Lee Kunwoo. 1999. Principles of CAD/CAM/CAE Systems. Addison Vesley Longman, Inc.

Reference Books:

1 Rao P.N.. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.
2 Sareen Kuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand & Company Ltd., New Delhi.

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Vishwavidyalaya, Indore